

**APPENDIX B**  
**APRIL 1999 MULTIBEAM BATHYMETRY**  
**AND SIDE SCAN SONAR SURVEY**

FUGRO WEST, INC.



**BATHYMETRY AND SEAFLOOR FEATURES SURVEY  
MOBIL SEACLIFF PIER COMPLEX  
ABANDONMENT PROJECT**

**VENTURA COUNTY, CALIFORNIA**

**APRIL 1999**

*Report prepared*

*for:*

**Padre Associates, Inc.  
5450 Telegraph Road, Suite 101  
Ventura, CA 93003**



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Fugro West, Inc., W.O. #99-83-5841

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## TABLE OF CONTENTS

	<u>Page</u>
<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 SURVEY OPERATIONS OVERVIEW.....</b>	<b>1</b>
<b>3.0 SURVEY INSTRUMENTATION .....</b>	<b>2</b>
3.1 NAVIGATION AND POSITIONING SYSTEM.....	2
3.2 GPS INERTIAL MOTION REFERENCE SYSTEM .....	3
3.3 MULTIBEAM BATHYMETRY AND SONAR SYSTEM.....	3
<b>4.0 SURVEY PROCEDURES .....</b>	<b>6</b>
4.1 MULTIBEAM BATHYMETRY.....	7
4.2 SIDE SCAN SONAR.....	7
<b>5.0 DATA PROCESSING TECHNIQUES .....</b>	<b>8</b>
5.1 NAVIGATION PROCESSING .....	8
5.2 MULTIBEAM BATHYMETRIC DATA PROCESSING.....	8
5.3 SIDE SCAN SONAR PROCESSING.....	9
<b>6.0 RESULTS.....</b>	<b>10</b>
6.1 MULTIBEAM BATHYMETRY.....	10
6.2 SIDE SCAN SONAR.....	12
<b>7.0 DESCRIPTION OF APPENDICES.....</b>	<b>12</b>

## APPENDICES

- Appendix A** Survey and Geodetic Parameters
- Appendix B** Survey Personnel
- Appendix C** Survey Map

## 1.0 INTRODUCTION

On April 17, 1999, Fugro West, Inc. (Fugro) under contract to Padre Associates a high precision Multibeam Bathymetry and Side Scan Sonar Survey of the abandoned Seacliff Pier Complex. This survey project was conducted as part of pier abandonment procedures.

Fugro conducted the full coverage side scan sonar survey for confirmation of structure and debris removal. The results of the side scan survey have been used to prepare a *Bathymetry and Seafloor Features Map* of the are pier and surrounding area. The side scan survey as well as the results of the survey and survey map are provided in this report.

We note that the side scan records show information relative to rock and debris that protrudes up above the existing seafloor. Debris or rock that is buried by seafloor sediments or a mobile sand layer is not visible on the side scan records.

## 2.0 SURVEY OPERATIONS OVERVIEW

**Vessel.** The R/V *Julie Ann* was used as the survey platform for the side scan sonar survey. The *Julie Ann* is a dedicated purpose built 26-foot Hydrographic and Geophysical Survey Vessel that is owned and operated by Fugro West.

**Date of Survey.** The R/V *Julie Ann* was mobilized with the navigation, sonar, and bathymetry systems at Fugro's Ventura facility on April 16, 1999. The vessel and crew departed Ventura Harbor for the project site early on the morning of April 17, 1999, with survey operations commencing upon arrival at abandoned pier site. The survey was completed later that day after which the vessel and crew returned to Ventura Harbor. Field survey operations were conducted in fair weather.

**Survey Scope.** Sonar and bathymetric data for the survey were collected along 15 survey tracklines oriented east-west parallel to the main pier structure. The survey tracklines were planned to provide a theoretical minimum 200 percent

coverage of the seafloor in the survey area and were oriented to provide optimum coverage of the area. Sonar imagery and bathymetric data were acquired concurrently during the survey. Vessel speed averaged approximately four knots during the survey.

### **3.0 SURVEY INSTRUMENTATION**

All survey and positioning equipment was mobilized onboard the Julie Ann at Fugro's offices in Ventura. The vessel arrived at Ventura completely mobilized. Onsite multi-beam calibration procedures were followed to optimize data quality. The following sections contain a detailed narrative related to survey instrumentation.

#### **3.1 *Navigation and Positioning System***

Wide area DGPS was used to position the survey vessel. GPS is a satellite-based positioning system operated by the U.S. Department of Defense. A "wide area" application operates with correction values applied to a stand alone GPS receiver from base stations located over large distances. DGPS corrections were supplied to the system using the STARFIX II network. This differential network is a nationwide system operated by the Fugro subsidiary John E. Chance and Associates. STARFIX II broadcasts differential corrections via a communications satellite downlink to field receivers.

The vessel position information is linked to an onboard Pentium-based personal computer running Hypack navigational software. Hypack is an advanced PC-based Windows navigation system designed for both surface and sub-surface vehicle positioning. A helmsman's display continually updates the true vessel position, the track-lines, distances off line, and distances along line. Other common I/O interfaces include connections to gyros, echo sounders, side scan sonar, fluxgate compasses, acoustic tracking systems, or virtually any receiver/sensor capable of a standard serial interface.

For this survey, the Hypack navigation system was interfaced to the onboard POS/MV Integrated DGPS / Inertial Reference System. The system uses two embedded Novatel 12 Channel GPS receivers with final position generated from the inertial unit. The update rate is one-second and the system has a horizontal accuracy of 1.5-meter (RMS) with DGPS corrections. The systems GPS engines receive ranging information from the same satellites as the reference stations. The STARFIX II system also receives the range corrections from the onshore reference stations. These corrections are applied to the DGPS receiver's satellite data to produce a corrected accurate position of the vessel in real-time that drives the inertial unit. This inertial position is then passed to the multi-beam data collection system, the side scan sonar system, and the navigation computer.

### **3.2 *GPS Inertial Motion Reference System***

The TSS POS/MV 320 GPS/Inertial Motion Reference System delivers full 6 degree-of-freedom position and orientation solutions for marine survey vessels. The POS/MV outputs all motion variables at high rate: Position, Velocity, Heave, Roll, Pitch, True Heading, Acceleration Vectors, Angular Rate Vectors. The system combines GPS/DGPS with rugged high-quality inertial sensors. The system measures true heading together with roll and pitch to 0.05 degree accuracy or better under dynamic conditions including hard turns and rapid acceleration or deceleration with heave accuracy of 5cm or 5% all in real-time.

### **3.3 *Multibeam Bathymetry and Sonar System***

The Reson Seabat 8101 transmits a fan beam with a vertical beam width of 1.5 degrees at 240 kHz. The 101 simultaneous receive beams have a vertical beam width of 15 degrees, and a horizontal beam width of 1.5 degrees. Convolution of the transmit and receive beam patterns, will result in 101 individual beams with a square beam width of 1.5 degrees providing total swath coverage of 7.4x water depth.

**Bathymetry.** The Seabat's 101 beams are sampled at intervals corresponding to 1.25cm range resolution, and the intensity data is displayed in full real time, together with the readout of the detected bottom. This ability to display the raw

sonar data gives the operator excellent quality check facilities. The data reduction factor from raw data to digitizer is approx. 5000. Apart from an instant quality check the sonar intensity image and the corresponding digitized bottom samples can be recorded on a VCR for future use, and documentation. It also allows the operator to detect features that cannot be described in the reduced data set.

The 101 detected bottom samples are read out on a serial port up to 30 times a second. once every 500 ms. The format is X,Z relative to the acoustical center of the sonar head. Compensation for Heave, Pitch, and Roll as well as navigation is done externally.

**Side Scan Sonar.** Two side scan sonar systems were utilized on the project. An Edgetech 260 seafloor mapping system was the primary sonar. Sonar data was also collected with the Seabat 8101 System as outfitted with side scan sonar capability and is ideal for shallow water operations and general site surveys where co-location using both bathymetry and side scan is desirable.

The Edgetech 260 digital dual frequency side scan sonar system was used to acquire seabed imagery. The sonar imagery was acquired along the same survey lines and concurrently with the bathymetry data. The Edgetech sonar system consists of a transceiver/graphic recorder unit, a Kevlar tow cable and towfish. The towfish transmits and receives acoustic energy via two transducers located along each side of the towfish body. The 260 system emits a 100 or 500 kHz acoustic pulse directed towards the sea floor. The acoustic energy reflected back to the transducers is converted into electronic signals within the towfish and sent back to the recorder via the multi-conductor tow cable. The 260 recorder processes, amplifies, and displays the returned signals as a trace on a mylar based thermal paper. As each successive signal is displayed on the recorder, a graphic representation of the sea floor is constructed, thus producing a record appearing similar to an aerial photograph.

The side scan survey was designed to optimize resolution of the side scan sonar records to support interpretation of possible debris, hard-bottom features, and



other anomalies. During field operations, the sonar was tuned and adjusted to find the best combination of control settings and tow fish altitude that yielded the best resolution. For this survey, the sonar was set to acquire 500 kHz imagery. A 50-meter (164 feet) slant range per channel was utilized on all survey tracklines. These operating conditions permitted better than 200 percent coverage and a clear view beneath the tow fish from adjacent lines. These data were displayed on the Edgetech recorder aboard the vessel. Vessel speed from the navigation computer was continually input to the side scan sonar system for automatic longitudinal correction of the sonar records.

In addition to the Edgetech sonar the Fugro Seabat 8101 system includes changes to the sonar head and topside processor to enable the measurement of side scan sonar data, which is made available in digital format.

With side scan, the primary intent is to form an image of the sea floor which can be used to locate and identify features and bottom conditions. Each sonar ping is used to generate a line of data. Each line contains a series of amplitudes representing the signal return vs. time or range. A higher amplitude indicates a strong reflector, which may be either the near side of a target or a more reflective surface. Low amplitudes may be the shadow of a feature or a less-reflective surface. When a series of these lines are combined and displayed, as the vessel moves along the track, a two-dimensional image is formed which provides a detailed picture of the bottom along either side of the vessel.

The side scan data is output as an array of amplitude values which represent the amplitudes for each sample cell in the beam from a single ping. The side scan beam has the same 1.5° along-track beamwidth as the bathymetry beam, but the across-track resolution is determined by the sampling rate rather than the beamwidth. The result is that each amplitude value represents an area 1.5° wide by 5 centimeters. The side scan beam is designed with a much wider beamwidth than the bathymetry beams so that each beam has a field of view from very near the vessel out to the maximum slant range of the sonar.

**Computer Data Acquisition System.** The Seabat 6042 combines hardware and software designed and developed to enable marine survey operators to

monitor their progress and make critical decisions in real time to support their operations. Whether for pipeline placement, "rock dumping, dredging control, or hydrographic survey operations", the Seabat 6042 can record and provide the required information.

The operator is in full control of each area of the Seabat 6042 process from data storage to information display. Numerous pre-defined windows are available to view collected and corrected multibeam data, single/dual profile's, plan view, 3D wiggle, and water-fall type displays can be selected. The Seabat 6042 time tags all received sensor data to an accuracy of one millisecond, interfaces to a Grid Coordinate System, and stores all raw data for instant, replay or transfer to a chart mapping system.

**Sound Velocimeter.** An AML SV Plus velocimeter is a lightweight, rugged, intelligent profiler which records high resolution sound velocity profiles of a water Column to depths of 5000 meters. Sound velocity is measured directly using an acoustic time of flight sensor rather than calculated from CTD measured parameters. The SV Plus offers the options of logging data continuously, at user selected depth increments, time increments, sound velocity increments, or upon request. The output format can be configured for "real" computed engineering values or "raw" integers for post processing. A standard feature of every SV Plus is AML's powerful, user friendly "*Total System Software*" TSS allows for viewing, editing, printing and graphing of data logged by the instrument.

## 4.0 SURVEY PROCEDURES

The pier survey covered an area of approximately 1,950 feet x 3,500 feet with water depths ranging from approximately 10 to 38 feet. To provide complete coverage of the area, data was collected along 15 survey lines.

Line spacing was utilized to provide for 200% coverage of the seafloor (for multibeam) even in the event of extreme vessel roll conditions, and irregular vessel line steerage.

A summary of the field operations, instrumentation deployment methods and survey layouts for data acquisition is discussed in the following sections.

#### **4.1 *Multibeam Bathymetry***

Prior to operations a comprehensive calibration was carried out to calibrate the different components of the multi-beam system. The multibeam calibration accurately measures the angular mounting components of the correction sensors (roll, pitch, and yaw) - errors in these measurements can lead to inaccurate surveys. The calibration test is a data collection and processing procedure to calibrate these angles along with position system latency. These calibration tests were conducted prior to commencing field operations.

During survey operations all correction sensor and multibeam data was time tagged and logged with the 6042 data acquisition system. At the start of the survey speed of sound in seawater was determined by a sound velocimeter profile. Correction sensor calibration factors and sensor offsets were applied during data collection. Sound velocity profile data and tide corrections were applied in post processing, and correlated with the survey data.

#### **4.2 *Side Scan Sonar***

The side scan system was adopted for this survey to provide sonar imagery of debris and bedrock features. The side scan sonar records can be used to provide interpretation of possible debris, hard-bottom features, and other anomalies. During field operations, the sonar was tuned and adjusted to find the best combination of control settings that yielded the best resolution.

Both sonar systems were operated at optimum instrument settings based on changing water depth. Side scan data was collected concurrently with the bathymetry along the same survey lines as the multibeam system. These data were displayed shipboard on the Edgetech recorder and the 6042 data acquisition system while slant range and speed correction were applied. During the field survey the sonar sensors were hard mounted on the side of the survey vessel.

## **5.0 DATA PROCESSING TECHNIQUES**

The following sections detail the post-processing procedures for each system. All mapping was completed at a workstation using TerraModel and AutoCAD. No digitizing of paper records was used in order to provide the most precise positions of features possible. Personnel involved with all phases of the survey and subsequent data processing are listed in Appendix C.

Initial bathymetric data processing was conducted at the site to verify data quality and coverage. Final data processing and presentation was performed at the Fugro office in Ventura, California. Data collected during the survey were excellent due to favorable weather along with careful operation of the survey instruments. The following sections describe the data processing techniques used to reduce the raw field data to its final form for presentation.

### **5.1 *Navigation Processing***

Appendix B lists the navigation survey parameters used during the acquisition of data and subsequent data reduction. Navigation data recorded during the project were edited and utilized to map the data from the Seabat sensors

### **5.2 *Multibeam Bathymetric Data Processing***

Two data processing software packages were used for all of the multi-beam data. Hysweep by Coastal Oceanographics was used to edit and bin the raw multi-beam data set consisting of several million discrete xyz data points. A sophisticated data decimator by was utilized to thin the binned data set prior to modeling and contouring of the data.

Terramodel and Terravista Digital Terrain Modeling (DTM) software packages by Spectra Precision were used to contour and generate 3-D models of the edited bathymetry data and produce the final map. Processing procedures are outlined as follows:

- Raw multi-beam data collected with the Reson 6042 was converted to Hypack's Hysweep format using Reson's R6042 program.
- Tide and Sound Velocity correction data files were developed in Hypack format from sound velocimeter data and tidal reduction curves generated from NOAA tidal data for the area.
- Data coverage was verified using Hysweep's Replay mode and a 2 meter BIN size MATRIX file was constructed.
- Hypack's Sweep Editor was used to merge and edit the raw multi-beam, Tide, Sound Velocity Profile, Heading, and Motion Sensor data to produce edited x,y,z data points corrected to MLLW. Valid data points were selected based on using only Quality 3 data from the Seabat. Data points registered as Quality 0 through 2 were discarded from the data set.
- The corrected x,y,z, data points were then imported into Hypack's Sort and Mapper functions and merged with the 2 meter BIN Matrix file. Edited data was then processed into a 2 meter grid size with the average of the grid readings placed in the center of the grid cell to create the final data set.

The final data set was imported into the Terramodel DTM software to produce the bathymetric contours for the final map. The contours are shown on the Bathymetry and Seafloor Features Maps located in the Appendices at the back of this report.

### **5.3 Side Scan Sonar Processing**

Side scan sonar records were analyzed in conjunction with the bathymetry data for evidence of objects on the seafloor and other evidence of human activity and geophysical processes. The objects of search included all sonar features with acoustic shadow (indicating projection above the seafloor) and seafloor topographic features such as mounds, depressions, rises, scour and areas of disturbed seafloor indicated by disposal activities and anchor drag and trawl scars. Areas of seafloor change, debris, and bedrock outcrop were also noted

and mapped as part of the survey. All side scan sonar data were analyzed in conjunction with the multibeam data. All such features, or clusters of such features, were plotted at their respective locations on the Bathymetry and Seafloor Features Map. In addition to the known objects, the sonar system detected a number of smaller debris targets. Target detection by the sonar system can vary depending on the physical orientation of the target or the presence of small, localized undulations of the seabed.

## **6.0 RESULTS**

Data interpretation was performed at the Fugro office in Ventura, California. The following sections describe the bathymetry and seafloor features observed from the field data for the survey.

### **6.1 *Multibeam Bathymetry***

Bathymetric contours referenced to Mean Lower Low Water (MLLW) for the area are mapped on the *Bathymetry and Seafloor Features Map*. Water depths within the surveyed area range from 8 feet near-shore to 38 feet along the southwest edge of the surveyed area.

The most notable topographic anomalies include a rock outcrop detected just to the south of the pier near the middle. It protrudes approximately 3 – 4 feet above the surrounding seafloor. Two other topographic anomalies are the casing remnants at the western end of the pier.

The 3-D graphic on the following page depicts the seafloor topography of the entire complex area. Noticeable are the two casing remnants as shown in Inset #A and rock outcrops in Inset #B.

***3d Bathymetry Figure***

## **6.2 Side Scan Sonar**

Side scan imagery shows that bedrock outcrops cover a large portion of the survey area as seen on previous surveys. There are very small patches of kelp identified in the area. Several small areas of debris targets were identified near the pier structure. What appears to be a pipeline is visible and extends from near the pier in a west-southwest direction towards a debris pile west of the pier.

Piling remnants were seen in two locations along the pier line. A section of exposed piles approximately 275 feet in length was located mid way along the structure at about 22 feet deep. A second area approximately 250 feet in length was noted to be 300-350 feet offshore in about 12 to 20 feet of water.

Several relatively large areas of coarse textured seafloor were noted. The coarse textured site located furthest inshore is shows up as sand-waves on the sonar records.

## **7.0 DESCRIPTION OF APPENDICES**

**Appendix A** “*Survey and Geodetic Parameters*”, detailed information on the geodetic parameters utilized on the project.

**Appendix B** “*Survey Personnel*”, provides a list of Fugro personnel on the project.

**Appendix C** “*Survey Map*”, Bathymetry and Seafloor Features Map



## **APPENDIX A**

### **SURVEY AND GEODETIC PARAMETERS**

## **SURVEY AND GEODETIC PARAMETERS**

### **Units**

Mapped Horizontal Linear units are Feet

Mapped Vertical Units are Feet

Angular units are degrees (°).

Times are Pacific Standard Time, UTC minus 8 hours, and Pacific Daylight Time, UTC minus 7 hours, during daylight savings time periods.

### **Geodetic Parameters**

Operational data and positions were output from the DGPS in Latitude and Longitude on the WGS 84 spheroid and then transformed to UTM Zone 11 Coordinates on the North American Datum of 1983 (NAD83). Final maps and deliverables were produced using California State Plane, NAD27, Zone 5. The following spheroidal and projection parameters were used:

<u>NAD83</u>		<u>NAD27</u>	
Spheroid	:GRS80	Spheroid	:Clarke 1866
Semi-major axis	:6 378 137.0m	Semi-major axis	:6 378 206.40m
Semi-minor axis	:6 356 752.3142m	Semi-minor axis	:6 356 583.80m
Flattening	:1/298.25722	Flattening	:1/294.97872
<u>UTM Zone 11</u>		<u>CAL ZONE 5</u>	
Latitude of Origin	:0° 00' 00"N	Latitude of Origin	:33° 30' 00"N
Central Meridian	:117° 00' 00"W	Longitude of Origin	:118° 00' 00"W
False Easting	:500,000	False Easting :	2,000,000
False Northing	:0.0	False Northing	:0.0
Scale Factor CM	:.99996	Scale Factor CM	:1.0

### **Vertical Datum**

The vertical datum reference for this project was Mean Lower Low Water (MLLW)

## **APPENDIX B**

### **SURVEY PERSONNEL**

## **SURVEY PERSONNEL**

### **PROJECT MANAGER**

Jeff Carothers

### **FIELD TECHNICIANS**

Joe Mucha

Navigation

Kevin Morris

Geophysical Technician

### **REPORT PERSONNEL**

Jeff Carothers

Data Processing/Mapping/Reporting

Shawn Johnson

Data Processing

Kevin Morris

Data Processing

## **APPENDIX C**

### **BATHYMETRY AND SEAFLOOR FEATURES MAP**